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A Review on Intake Manifold

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***Abstract*: 3D Printing also known as Additive Manufacturing process builds a 3D product by successive adding of materials layer upon layer. It provides facilities like freedom in design, mass customization, waste reduction etc. Since it can manufacture complex structures at rapid rate. This paper aims at design considerations, geometric optimization and fabrication process of intake manifold to achieve optimum engine performances. This paper also gives an overview of conventional manufacturing process and materials used for intake manifold, advantages and drawbacks of 3D printing in fabrication of intake manifold.**

***Keywords*: Intake Manifold.**

1. Introduction

A. *Intake Manifold*

The intake manifold is a system designed to deliver air to the engine through pipes connected to each cylinder called runners. The length of these pipes and to a certain extent its diameter must be chosen carefully as they will determine the resonant frequencies of the manifold.

Certain considerations are to be taken while designing intake manifold, they are as follows,

1) Maintain minimum pressure loss, as pressure loss results in a decrease in power.
2) Maintain equal static pressure distribution in the plenum, as this will cause an equivalent pressure drop across each runner, thus providing an even flow to each cylinder.
3) Minimize bends and sudden changes in geometry, as these effects can cause pressure loss and decrease air flow amount into the cylinder
4) Maximize air velocity into the cylinder, as this provides a better mixture of fuel and air, which results in better combustion and performance, and
5) Minimize the mass of the system, a common goal of every subsystem of the system.

B. *Intake Manifold Manufacture*

Traditionally, intake manifold were designed via bonding multiple aluminium pieces (either bent pieces of aluminium tubing or casted aluminium components), together with multiple welds. Owing to the inherent geometric limitations imposed by the existing manufacturing process (bending and welding), it is difficult to design and fabricate a system in which,

- Pressure losses are kept to a minimum.
- Equal charge is provided to each cylinder.

In this paper, a new manufacturing process (3D Printing) for fabricating intake manifolds of 4 cylinder in-line CI engine is presented. Intake manifold id fabricated via. FDM (Fused Deposition Modeling).

The geometry freedom offered by FDM allows a designer to ensure even static pressure distribution throughout the intake and an equal charge to each cylinder. Furthermore, as FDM allows creation of the entire manifold system as a single piece, the need for welds and other fasteners is eliminated resulting in an expected reduction in mass.

C. *Materials*

The traditional materials used for intake manifold were cast iron and aluminium alloy. Until 1990s, most automotive intake manifolds assemblies were made from cast iron because of lower cost or from aluminium which has lighter weight. Intake manifolds made from plastics began to gain popularity during 1990s, because they offered lower weight and cost combined. Dissimilar materials such as plastics, aluminium and iron all have different and contraction rates as they change temperature, so gaskets that provide a seal between an intake manifold and metal cylinder head must be flexible and durable enough to withstand serious pulling and twisting forces. Composites materials offer advantage, low cost, lower weight, ease of assembly, better insulation, improved air flow, excellent strength to weight ratio and is recyclable.

2. Literature review

David Chalet et al. in 2011: studied on inlet manifold of internal combustion engine by frequency modeling of the pressure waves, they perform the simulation of pressure waves on inlet and exhaust manifolds of internal combustion engine, which remains challenging. In their study they design new model which is presented in order to investigate these pressures waves without the use of a one-dimensional explanation of the system. They study on the system which using a frequency approach. In order to originate this model, they used a dynamic flow bench. Latter they modified flow in order to generate waves in fluid which may be in moving condition or stationary condition.

M.A. Ceviz et al. in 2010: further proceed the research of Sattler et al. [1999], Philip E.A. Stuart [2005] and M.A. Ceviz [2006] and, he studied the effects of variable intake plenum length on the engine performance characteristics of a SI engine with MPFI system using electronically controlled fuel injectors. He describes that, the intake manifold only transportthe air from plenum to engine cylinder whereas, the fuel was injected onto the intake valve, the and also found that supercharging effects of the variable length intake plenum will be different from carbureted engine [4-10, 14,17]. He carried out the engine test with the purpose of establishing a base study to design a new variable length intake manifold plenum. He takes consideration of Engine performance characteristics such as brake torque; brake power, thermal efficiency and specific fuel consumption into to estimate the effects of the different length of intake plenum.

Mark Claywell et al. in 2006: study on design of intake restrictor required by the Formula SAE event to limit the performance, keep costs low, and maintain a safe racing experience. As the engine performance was limited by the intake restrictor. Thus researchers approach the

method of ramifications of the restrictor on the engine, which lead to enhancement in engine performance and allow an edge over the competition. They use Ricardo's software WAVE (1D) and VECTIS (3D) to study the engine performance [15, 16]. There primary area of improvement was determined by the use of comparatively small diffuser angles.

M.A. Ceviz in 2006: studied on Intake plenum volume and its influence on the engine performance, cyclic variability and emissions, Inlet manifold system connected to the engine intake valve, through which the mixture of air or air-fuel is introduced into the engine cylinder. They found that the flow in intake manifolds was very difficult to examine. Since most of engine companies are concentrated on variable intake manifold technology due to their improvement on engine performance [7-9, 13]. He examines the effects of intake plenum volume variation on engine performance and emissions to constitute a base study for variable intake plenum [14, 17].

Philip E.A. Stuart in 2005: further proceed the research of Sattler et al. [1999] and Davis et al. [2001] and, He designed a continuously variable intake manifold with a flexible plenum, which communicates with intake manifold of the internal combustion engine, and mainly to an intake manifold having an flexible plenum to offer adjustable runner length during engine operation. The intake manifold assembly was including a plenum volume at that time and mounted for movement within housing [8]. There was movement of the plenum within the housing in order to response to a drive system to define an effective runner length.

M.F. Harrison et al. in 2003: further proceed the research of M.F. Harrison et al. [2002] and A. Dunkley et al. [2003] and study a linear acoustic model for multi-cylinder internal combustion engine intake manifolds including the effects of the intake throttle, that can be used as part of a hybrid frequency/time domain technique to calculate the intake wave dynamics of applied naturally aspirated engine. These technique permits the researcher to virtually create a model of manifold of complex geometry.

A. Dunkley et al. in 2003: study the effect of acoustics of inlet manifold for motor racing. They design the tuned inlet manifold for naturally aspirated racing engine and shows that volumetric efficiency and engine speed can be achieve in excess of 125% and 18,000 rev/min. since Formula SAE intake manifold divided into three separate parts, plenum,

runner cylinder, and restrictor.

M.F. Harrison et al. in 2002: describe the acoustic wave dynamics for intake manifold of an internal combustion engine shows the better understanding of a linear acoustic model. They performed on a Ricardo E6 single cylinder research engine and described model developed together with a set of measurements. The simplified linear acoustic model described by them create an estimate of the pressure time history at the port of IC engine, that agrees quite well with the measured data from the engine equipped with a simple intake system.

Davis et al. in 2001: designed multiple stage ram intake manifold for a four-cycle internal combustion engine to minimize imbalances air/fuel ratio and volumetric efficiency. Intake manifold consisting of a plenum chamber contained at least two stages of ram; the first Stage contained ram tubes, which transport the air/fuel mixture to the plenum chamber from the throttle body.

Sattler et al. in 1999 found that, the previous research broken conventional intake manifold into three separate parts, plenum, runner cylinder and a supplement portion. Since a fixed runner length can be tuned optimally for a particular engine speed. In order to overcome this, a continuously adjustable runner length was needed to design. So that, they designed continuously adjustable runner length manifold for an internal combustion engine. Incorporating the purpose of a plenum, supplement flange, and continuously adjustable length runner into a plastic box designed from distinct shaped sections.

C. L. Lee in 1997 found the two possible ways, which can used to increase the volumetric efficiency. The two solutions were variable intake manifold geometry and variable valve timing technology for intake and exhaust valves. By watching the scenario of that time, he designed a different type of variable intake manifold length for internal combustion engine, which may vary the geometry of inlet through which air was flowing. Since the primary function of an air inlet manifold for internal combustion engine was to feed desired amount of air to the engine combustion chamber [1-8].

Futakuchi in 1984 designed an improved intake manifold, which enhance both charging and volumetric efficiency of the engine throughout the large range of engine speed and load. He found that the efficiency of the engine intake and combustion, especially at low and medium speeds can be improved by providing an auxiliary intake that communicates with the combustion chamber and that had a relatively small effective area. He found that such auxiliary intakes to result in a high velocity and turbulence in the combustion chamber at ignition time and that improve flame propagation and engine running.

Jim C. Taylor in 1953 designed an inimitable type of intake manifold for internal combustion engines. The primary goal of the research was to design an intake manifold to produce maximum operating efficiency in internal combustion engines. Another object of the research was to provide an intake manifold of the character indicated above enabling an internal combustion engine equipped therewith, to completely fill its cylinders with fuel mixture during the intake stroke, and further object of the research was to provide an intake manifold of the character indicated above adapted to prevent pumping losses of the engine equipped with the manifold by reducing atmospheric pressure restrictions as far as possible.

D. A. Sullivan in 1939 designed an improved intake manifold for and method of supplying fuel mixture to combustion chamber to improve the volumetric efficiency of the engine. One of the goal of the research was to offer comparatively short passages splitting without any obstructions passage for flow of the fuel mixture on all cylinders of an engine of this nature and that therefore, affords free breathing action, another goal of the research was to provide a manifold of such kind in which the air-fuel ratio produced by carburation means remains same throughout the intake manifold.

W. A. Whatmough in 1937 recognized that pulsating flow inside the intake manifold had certain disadvantages due to pulsation. He also observed that there were both static and dynamic effects in the channel in which there was a fluid flow. The static effects were difference due to pressure and dynamic effects in the channel was difference due to velocity.

E. R. Burtnett in 1927 designed first gaseous-fuel manifold for two stroke cycle internal combustion engines of the type in which no inlet valves are used to controlling for the entrance of gaseous fuel to the pre-compression chamber. The determination of this invention was to improve the volumetric efficiency of the engine. As result of this invention, the quick demand developed by suction stroke from one of the pistons within the engine, the gaseous fuel volume within the manifold does not cause an unexpected or unusual of velocity and pressure on the carburetor.

3. Conclusion

This paper presented an overview on intake manifold.

References

[1] Burtnett E. R. (1927). Inlet Manifold for Internal Combustion Engines, www.google.com/patents/US1632880.
[2] Whatmough W. A. (1937). Means for Automatically Modifying the Flow of Pulsating Fluid Flow Streams. www.google.com/patents/US2080293
[3] Sullivan D. A. (1939), Intake Manifold, www.google.com/patents/US2160922.
[4] Taylor Jim C, (1953). Intake Manifold. www.google.com/patents/US2636486
[5] Futakuchi Y, (1984). Engine Intake System, www.google.com/patents/US4469067
[6] Futakuchi Y, (1986). Engine Intake System. www.google.com/patents/US44628879
[7] Lee C. L, (1997). Variable Air Intake Manifold. www.google.com/patents/US5638785
[8] Sattler Eric R., Myers J. S. Haspel M. J, (1999). Continuously Variable Runner Length Manifold, www.google.com/patents/US5950587
[9] Davis G. G., Thurm K, (2001). Intake Manifold with Multiple Stage Ram Induction, www.google.com/patents/US6209502
[10] Harrison M.F., P.T. Stanev, A Linear Acoustic Model for Intake Wave Dynamics in IC Engines, Journal of Sound and Vibration269 (1+2) (2004) 361–387.
[11] Dunkley A., Harrison M.F., The Acoustics of Racing Engine Intake Systems, Journal of Sound and Vibration 271 (2004) 959–984.
[12] Harrison M.F., I. De Soto, P.L. Rubio Unzueta, A Linear Acoustic Model for Multi-Cylinder IC Engine Intake Manifolds Including the Effects of the Intake Throttle, Journal of Sound and Vibration, 2004, pp. 975–1011.
[13] Stuart Philip E.A. (2005). Continuously Variable Air Intake Manifold with Adjustable Plenum, www.google.com/patents/US6837204
[14] Ceviz M. A, Intake plenum volume and its influence on the engine performance, cyclic variability and emissions. Energy Convers Manage, 2006.
[15] Claywell, M. R., Horkheimer, D. P., and Stockburger, G. R., “Investigation of Intake Concepts for Formula SAE Four-Cylinder Engine Using 1D/3D (Ricardo WAVE-VECTIS) Coupled Modeling Techniques,” SAE 2006 Motorsports Conference, 2006.
[16] Ceviz M. A, Akın M. Design of a new SI engine intake manifold with variable length plenum. Energy Convers Manage, 2010.
[17] Chalet D. Alexandre M. Jerome M., Hete J. F, “A frequency modelling of the pressure waves in the inlet manifold of internal combustion engine. Applied Energy, vol. 88, pp. 2988–2994, 2011.